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ABSTRACT

Two experiments were conducted to investigate why lecture notes aid expository writing after a 1-week delay between lecture acquisition and essay writing. Experiment 1 examines the context hypothesis that deactivation of lecture schema must occur before attempts to reinstantiate context can aid writing. Results with 74 undergraduate students did not support this hypothesis. Experiment 2 examined the spacing-effect hypothesis that full processing of lecture notes can occur only after a delay (i.e., distributed practice). Either immediately or 1 week after viewing a 19-minute videotaped lecture on creativity, 27 undergraduates reviewed one of three kinds of lecture notes entered on a Macintosh IIsi: conventional, matrix, or outline. Using secondary-reaction task methodology, delayed-review subjects responded significantly slower than immediate-review subjects. In addition, subjects reviewing conventional notes had significantly slower reaction times than those reviewing matrix and outline notes. (Contains 8 references.) (SLD)

External-Storage Effects on Writing Processes: Delay Hypotheses

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Abstract

We conducted two experiments to investigate why lecture notes aid expository writing after a one-week delay between lecture acquisition and essay writing. Experiment 1 examined the context hypothesis that deactivation of lecture schemata must occur before attempts to reinstantiate context can aid writing. Results did not support this hypothesis. Experiment 2 examined the spacing-effect hypothesis that full processing of lecture notes can occur only after a delay (i.e., distributed practice). Either immediately or one-week after viewing a 19 min videotaped lecture on creativity, undergraduates reviewed one of three kinds of lecture notes entered on a Macintosh IIsi: conventional, matrix, or outline. Using secondary-reaction task methodology, delayed-review subjects responded significantly slower than immediate-review subjects. In addition, subjects reviewing conventional notes had significantly slower reaction times than those reviewing matrix and outline notes.

External-Storage Effects on Writing Processes

When students refer to notes or other external records during writing, their writing is more coherent and lengthier than if they write without referring to notes (Benton, Kiewra, Whitfill, & Dennison, 1993; Kellogg, 1988; Langer, 1984). Reviewing external records reduces memory load and frees the writer's attentional capacities for generating and organizing ideas. The advantage of external records is particularly evident after a delay between information acquisition and recall. After a *delay*, writers who are given lecture notes produce lengthier essays than writers who write without notes. However, on *immediate* writing tasks, students who review notes while writing do not write lengthier essays than students who write without notes (Benton et al., 1993).

Benton et al.(1993) proposed two hypotheses to explain differences between delayed and immediate external-storage effects on writing: the "context" hypothesis and the "spacing effect." The context hypothesis states that the context of encoding must be "lost" before attempts to reinstantiate context can facilitate recall (Corkill, Glover, Bruning, & Krug, 1988). Corkill et al. considered context loss to be "the deactivation of those schemata used to process text materials" (p. 310). Context loss could also refer to deactivation of schemata used to process lecture material. Reviewing provided lecture notes does not enhance writing processes until schemata originally activated during lecture viewing have been deactivated. Deactivation, apparently, could not occur in immediate writing, but it could occur in

delayed writing.

The spacing effect hypothesis comes from Dellarosa and Bourne (1985). They concluded that when learning trials are spaced rather than massed, subjects must engage in full processing of materials on each trial. However, when learning trials are massed, the material is already available in memory, so subjects can skim or superficially process the material. Provided notes may therefore receive full processing only when writing is delayed. Under immediate writing conditions, notes do not receive full processing, and students gain little from having them.

In Experiment 1, we examined the context hypothesis by inserting a distractor task between lecture viewing and immediate writing. Subjects in the treatment group spent 15 min responding to the Hidden Figures Test (distractor), whereas subjects in the control group spent 15 min reflecting on the lecture. If the context hypothesis is viable, then the distractor task should deactivate students' schemata for the lecture, which would require them to more fully process the lecture notes. In contrast, students who merely reflect on the lecture would most likely skim the lecture notes superficially prior to writing. Consequently, distracted students should write lengthier and better organized essays than students who merely reflect on the lecture.

In Experiment 2, we used secondary-reaction task methodology to examine the spacing effect. Specifically, we tested whether students differentially allocate attention to provided notes immediately following a lecture versus after a one-week delay. Lecture notes were entered on a Hypercard stack, and subjects read

them at their own pace by paging down a Macintosh IIsi display screen. Intermittent beeps signaled subjects to strike the keyboard space bar as rapidly as possible. If the spacing effect is a viable hypothesis, delayed subjects should respond slower to the secondary reaction task (the beep), because the loss from memory of information about the lecture requires them to attend more vigilantly to the lecture notes.

Experiment 1

Subjects, Setting, and Design

Seventy-four undergraduate students enrolled in an educational psychology class at a large midwestern university volunteered to participate for course credit. All activities took place in a large classroom. Students were assigned randomly to one cell of a 2 X 4 design. The first variable was context (review vs. distraction), and the second variable was lecture-note format, defined by the type of notes made available (conventional, outline, matrix, or no notes).

Materials and Apparatus

The materials included a videotaped lecture about types of creativity, a television monitor, three types of study notes, sheets containing directions about the study and about the writing assignment, the Hidden Figures Test, and pages of lined tablet paper for writing. The 19-min videotaped lecture contained 1,881 words and was delivered at a rate of 100 words per min on a 19-in. color television monitor. The lecture contained 121 ideas units based on a procedure developed by Kintsch and van Dijk (1978).

The conventional lecture notes were typed on five pages and

contained all of the 121 lecture ideas; they appeared in a list form paralleling the lecture presentation. Subtopics were not specified. The outline notes were typed on four pages and also contained all 121 lecture ideas; they were in a linear, outline form but provided major headings for topics and subheadings for subtopics. The matrix notes were typed on a single, oversized (38 cm X 20 cm) page. The 121 ideas were presented within the 45 cells of the matrix.

Procedures

The 74 volunteers assembled in a large classroom. The Experimenter distributed experimental packets randomly. Each packet contained code letters that assigned students to one of the four writing conditions, as defined by the notes provided. Written general instructions informed all participants that they would listen to a lecture without recording notes and then write an essay on a topic related to the lecture. Subjects were further told to remove all paper, pens, and pencils from their desks to prevent note-taking.

After general instructions were read, subjects viewed the videotaped lecture on types of creativity. After the lecture, approximately one-half of the students in each provided- or no-notes group (as designated randomly by packet code letters) were directed to sit and think about what they had learned from the lecture. The other half were told to remove the Hidden Figures Test from their packet and to complete as many of the items as they could. Both groups were given 15 min for these tasks. (This was 5 min longer than Glover, Bullock, and Dietzer (1990) gave

subjects in a similar test of the context hypothesis.)

After 15 min had expired, all subjects were given the writing assignment to compare and contrast the five types of creativity in the lecture in terms of their definitions, distinguishing characteristics, and myths. Writing instructions indicated that essays would be scored for both content and organization. Students belonging to the three provided-notes conditions were also told to remove the lecture notes from their packets and to refer to them during writing.

Results and Discussion

Three dependent measures were of interest: the number of words and text units (Bereiter & Scardamalia, 1987), and essay coherence (as measured by Bamberg's, 1983, five-point scale). Results of a 2 X 4 MANOVA, using analysis of unique sources, revealed no significant interaction effect of context (review vs. distraction) by note format (conventional, outline, matrix, or no notes), Wilks' lambda = .897, $F < 1$. In addition, there was no main effect for context, Wilks' lambda = .818, $F(9,155.91) = 1.49$, $p > .05$; and no main effect for note format, Wilks' lambda = .99, $F < 1$.

These results support earlier findings by Benton et al. (1993) that differences in note formats do not effect writing measures immediately following lecture. The fact that no differences were observed between students who reviewed versus those who were given a distractor task threatens the viability of the context hypothesis. Experiment 2 was designed to examine the spacing effect hypothesis.

Experiment 2

Subjects, Setting, and Design

Twenty-seven graduate students enrolled in a large midwestern university volunteered to participate for course credit. The Experimenter administered all activities individually in a small counselor-education laboratory room. The first variable of the design was writing condition (immediate vs. one-week delay), and the second variable was note-taking format defined by the types of notes provided (conventional, outline, matrix, or no notes).

Materials, Apparatus, and Procedures

The videotaped lecture and writing assignment were the same as in Experiment 1. The content and format for the three notes (conventional, outline, and matrix) were the same as in Experiment 1, except that they were entered on a Hypercard stack using a Macintosh IIsi. Subjects were assigned randomly to the three note-format conditions. The Hypercard stack was arranged so that subjects could scan up and down pages of the conventional and outline notes as well as across the page on the matrix notes. Subjects could advance through the notes at their own pace using arrow keys. In addition, a beep sounded intermittently. At the sound of the beep, subjects were directed to press the space bar as rapidly as possible. An internal clock recorded reaction time to the beep at ms intervals. The times for the beeps were determined randomly by a table of random numbers.

Consistent with Experiment 1, subjects were permitted 15 min to review notes. A digital clock appeared at the top of the computer screen throughout the review period so that subjects

could monitor their progress. Each set of notes was preceded by a practice session in which subjects could practice moving up and down (or across) the screen and practice pressing the space bar at the sound of a beep. After the 15-min review period, subjects were given the same writing assignment as in Experiment 1.

Results and Discussion

We performed a 2 (immediate v. delayed review) by 3 (conventional, outline, and matrix) ANOVA, using analysis of unique sources, on the average secondary reaction time for each subject. We found no significant review by note-taking format interaction, $F < 1$. However, as hypothesized, the average reaction time of subjects in the delayed review condition (M = 54.60 ms) was longer than for subjects in the immediate review condition (M = 47.54 ms), $F(1, 21) = 4.40$, $p < .048$, $MSe = 75.26$. This supports the spacing effect hypothesis, because subjects in the delayed condition averaged longer reaction times than those in the immediate condition. Delayed subjects apparently engaged in fuller processing of the lecture notes. Their enhanced attention to the notes made their secondary reaction times slower than that of subjects who reviewed notes immediately.

In addition, we found a main effect for note-taking format, $F(2, 21) = 3.92$, $p < .036$, $MSe = 75.26$. Fisher's LSD procedure (alpha = .05), using the harmonic mean of the sample sizes, revealed that the reaction times of those who reviewed conventional notes (M = 58.11 ms) were longer than for those who reviewed outline (M = 46.46 ms) and matrix notes (M = 48.56 ms). Apparently, subjects who reviewed conventional notes engaged in

fuller processing than subjects who reviewed outline or matrix notes. The most likely explanation for this finding is that outline and matrix frameworks permit learners to skim notes more rapidly than do conventional notes. Faster reading times require less attention, which enable subjects to respond more quickly to the secondary reaction task. To test this hypothesis, we must compare average reading times across conditions. At the time of submission, this analysis had not been conducted.

General Discussion

We reported preliminary findings on two experiments designed to examine why provided notes enhance students' expository writing after a delay between lecture acquisition and writing performance. We found no support for the context hypothesis in Experiment 1. However, Experiment 1 was flawed because subjects in the review condition were unsupervised. Glover et al. (1990) compared a distracted group with both unsupervised and supervised review groups. Glover et al. required subjects in the supervised group to write a paraphrase of the text they were assigned to review. They found that distracted students (who completed mathematics problems during the review period) recalled significantly more from a text than did subjects in the supervised group. We plan to conduct a third experiment that will compare a distracted group with supervised and unsuperivised review groups.

Although the results of Experiment 2 generally supported the spacing-effect hypothesis, some questions remain. First, we would expect to gain greater statistical power by including more subjects in the study. We plan to increase N from 27 to at least

60. Second, do average reading times differ between delayed and immediate conditions and between the three note-taking formats? Third, do reading times and reaction times change as subjects read further in the text of notes? We are currently analyzing data to answer the last two questions.

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